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ON THE PRODUCTION OF
PARASITES WITH THE
SERIES OF INSECTA AND
CALLED FAMILIAR
PLANTS AND HOUSES IN

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ON THE DESTRUCTION OF ELEPHANTS BY
PARASITES; WITH REMARKS ON TWO NEW
SPECIES OF ENTOZOA AND ON THE SO-
CALLED EARTH-EATING HABITS OF ELE-
PHANTS AND HORSES IN INDIA.

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At the Norwich Meeting of the British Association for the Advancement of Science in 1868 I exhibited two flukes which had been received from Veterinary Surgeon J. S. Thacker, of the Madras Army. They were handed to me by the late Dr. Baird, of the British Museum, having been kindly forwarded from India by Dr. Hugh Cleghorn, at Mr. Thacker's request. The parasites were labelled "Distoma taken from liver of elephant and forwarded for classification." I believed at the time that these entozoa were identical with flukes that had been some years previously obtained from the duodenum and biliary ducts of an Indian elephant, and which, though carefully preserved in the Boston Museum, U. S., had never been properly described. As verbally stated to the Association, the parasites were only briefly noticed by Dr. Jackson in his descriptive catalogue of the museum. Some two or three months previous to the time of which I speak fifteen specimens of fluke removed from Burmese elephants had been forwarded to and received by Professor Huxley from Rangoon, accompanied by a statement to the effect that they were the cause of an extensive and fatal disease in Burmah. Through the kindness of Prof. Huxley I was allowed to make use of his specimens for the purpose of comparison and identification, and thus it became evident that our specimens were identical. It was also tolerably certain that the species could be none other than that represented by the Boston specimens. Further examination having made it clear that the organisation of these flukes departed from the ordinary distome type, I named the parasite *Fasciola Jacksoni*, at the same time

offering, as far as I could, a suitable description and figure of the species (*Entozoa*, Supp., 1869, p. 80). Now, if reference be made to the appendix of the late C. M. Diesing's *Systema Helminthum*, it will be found that Jackson's statement had not escaped that helminthologist's notice, though, not having seen any specimens, he was not unnaturally led to place the species amongst the distomes, properly so called. In Diesing's subsequently published *Revision der Myzelminthen* the species is formally characterised as the *Distomum elephantis* of Jackson (*Sitzungsberichte d. Math.-nat. Cl. d. k. Akad. d. Wissenschaften*, Bd. xxxii, 1858). In my synopsis of the Distomidæ, which appeared in the *Journal of the Proceedings of the Linnean Society* for 1861, I also placed this form amongst the distomes, but I did not consider it to be a doubtful form as Diësing had done (*P. L. S.*, "Zoology," vol. v, p. 9). So far as I am aware these references exhaust the literature of the subject up to the time of the issue of my *Manual* in 1873, where at p. 13 the fluke in question is again briefly noticed. I may mention that several of Prof. Huxley's specimens were placed in the hands of Prof. Flower, Conservator of the Museum of the Royal College of Surgeons, under whose direction six of the flukes were selected, mounted, and added to the rich entozoological department of the Hunterian collection.

Interesting as the above facts are to the helminthologist, I should not introduce the subject into the pages of the *Veterinarian* were I not in possession of additional facts, tending both to confirm the statements originally communicated to Professor Huxley and to increase our knowledge of fluke diseases in general, as well as of the *rot* as it affects elephants in particular.

Moreover, so rapid are the strides of helminthology in reference to the correct understanding of epidemics involving both man and beast that, work as one may, it is almost impossible to do justice to the multitude of novel facts that are weekly, I might almost say daily, presented to our notice. Throughout the East, especially in India, members of the medical and veterinary professions, and also army officers, to judge by their frequent contributions, seem to be much more impressed with the importance of a thorough knowledge of parasites than do some of those who are placed in the van of the same professions at home.

About the middle of June last I received an interesting letter from Lieutenant-Colonel Hawkes, of the Madras Staff Corps, dated Secunderabad, the 12th of May, 1875, and in reference to the subject before us he writes as follows:—"My attention has been recently directed to a very unusual mor-

talities of elephants at this station. Out of twenty-eight elephants under my charge, no less than twelve have died within the last sixteen months, whereas the average annual mortality has been hitherto only two per annum out of thirty-eight on our establishment. In every case of death there appeared to exist serious organic disease quite sufficient to account for such death, but as the mortality increased I had a *post-mortem* examination made of each case; and although here, also, organic disease sufficient to account for death was present in each case, yet in every one of these elephants we found the liver-fluke in greater or less abundance."

Lieut.-Col. Hawkes next proceeds to say that he hopes again to address me on the same subject, and adds—"Meanwhile I have sent you a small box containing three bottles, one containing the liver-fluke (*Fasciola Jacksoni*) referred to in your work on the parasites of domesticated animals. It seems (to me) possible that the other two species of parasites may not have been brought to your notice.

"Both of these, namely, the 'Masuri' and the 'Soorti,' are very common in elephants. They are both found in the intestines only. The 'Masuri,' when present in any quantity, cause considerable disturbance, and the animal instinctively resorts to the *eating of earth*, which it consumes in large quantities until the bowels are acted on and the worm expelled.

"The Soorti is more common than Masuri, and does not seem to inconvenience the animal very much. I may add that the specimens of Soorti sent to you are somewhat shrivelled up, the spirit having been too strong, but the anatomical characters will still remain. When expelled from the animal the Soorti is a round white worm, like most of the threadworms; the Masuri, on the other hand, is of a delicate flesh colour."

The perusal of this letter having naturally raised my hopes of receiving some parasites that would prove new to science, I was much gratified when only a few days subsequently, through Messrs. Dawson and Sons, I obtained the entozoa in a good state of preservation. Accordingly I wrote to Lieut.-Col. Hawkes, stating that the flukes, of which he sent me no less than thirty-seven specimens, were clearly referable to the *Fasciola Jacksoni*; that the parasites (to which the natives of Hindostan apply the term "Soorti") were evidently examples of the *Ascaris lonchoptera* of the Vienna systematist (Diesing), previously called strongyles by Rudolphi; and that the parasites which he called Masuri

were trematodes which were, in my opinion, entirely new to science. I provisionally named the species *Amphistoma Hawkesii*, in honour of the donor. The bottle contained as many as forty-nine specimens.

In this place the readers of the *Veterinarian* will hardly look for a scientific and anatomical description of these various parasites, which will be more properly communicated to some one or other of our learned societies. In the mean time, however, I may remark that I have made inquiries of the keepers of the elephants at the Zoological Gardens as to whether they have ever seen entozoa that were passed by the animals under their care. They replied in the negative; the keeper of the African elephants (Scott) having since made frequent inspection of the fæces without success. I was the more anxious to secure information on this point since, during my frequent visits to the menagerie, I had observed that the African elephants (especially the female, which, by the way, has lately torn off the end of her trunk) were in the habit of swallowing large quantities of mud and dirt from small hollows in the ground near the great water-tanks in which they bathe. Professor Garrod, Prosecutor to the Zoological Society (who has dissected three elephants and who is always on the look-out for parasites), also assures me that there has been no trace of an entozoon in any of the Indian elephants examined by him in this country. In one dissected at Edinburgh the same negative result was obtained. From all the facts, therefore, at present in my possession, I have come to the conclusion that the habit of earth-eating displayed alike by Indian and African elephants is not necessarily due to the presence of flukes and other parasites, but rather that it is resorted to by these animals under any circumstances of intestinal irritation, whether created by entozoa or any other agent.

Lieut.-Col. Hawkes, in accordance with his conditional promise, has since supplied me with much fuller information; and his remarks are so thoroughly practical that only the fear of repeating some of the facts already given prevents my recording the whole of his long and very valuable communication. Dating his second epistle from Secunderabad on the 30th of July, he says—"Last night's English mail brought me your letter of the 30th of June, which is of the greatest interest. As I did not (for obvious reasons) previously enter into the subject so fully as I might have done, I proceed to offer a few more remarks. As regards the liver-fluke (*F. Jacksoni*) it appears from your treatise to have been first observed in 1847. The only other published notice

that I have been able to find of it is contained in a letter to a newspaper, dated 'Rangoon, 16th July, 1867,' and is signed 'R. B.' In this letter the unusual mortality of seven elephants in about fifteen days is attributed to the presence of this liver-fluke, the two other parasites (*Amphistoma* and *Ascaris lonehoptera*) being also present in the intestines."

Lieut.-Col. Hawkes does not, of course, mean to say that the writer "R. B." recognised the true nature of his amphistoma and ascaris 'finds,' but that, from the description given, the parasites were undoubtedly referable to the above-mentioned species, one of which is altogether new to science. Lieut.-Col. Hawkes appears to have lost two more elephants since he first wrote, for he says that he has lost fourteen, during the past eighteen months, out of a total of twenty-eight. He then proceeds—"In every case but one a *post-mortem* has been held by a veterinary surgeon, at which I have almost invariably been present. The 'cause of death' has been recorded by the various veterinary surgeons as follows :

Inflammation of the intestine	4
Inflammation of lungs	2
Inflammation of lungs and liver	1
Dropsical swelling	1
Splenic apoplexy	2
Old age	1
Atrophy of the heart	1
Sunstroke	1
No <i>post-mortem</i> held	1
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"Now [continues Lieut.-Col. Hawkes] in every case at which I was present *flukes were found in greater or less numbers* in the gall-duets of the liver, and the amphistoma was also as constantly present in the intestines, the Soorti (*Ascaris lonehoptera*), contrary to the general experience of the elephant attendants, being less frequently met with, though from its colour and slender shape it is not so easily detected among the huge mass of fæces as the larger amphistoma. In some cases flukes were in large numbers, apparently collected in bunches in the gall-duets, but disease of the liver did not necessarily appear to follow, nor where disease was actually present did it seem to bear a constant ratio to the number of flukes in the gall-duets. From the above casualty list you will see how various have been the diseases which are recorded as having been the cause of death ; and we have consequently found it impossible to satisfy ourselves to what extent, if any, the liver-fluke contributes to

originate these varied forms of disease. Notwithstanding the number of deaths and the fact that the flukes have been nearly always found at the *post-mortem*, I confess that up to the present we have been unable to single out any symptom from which the presence of flukes could be diagnosed before the death of the animal. The symptoms in all cases have been apparently those of the diseases from which the animals were found on *post-mortem* examination to have died. I will enclose in this letter an extraet from a memorandum drawn up for me by one of our most experienced veterinary surgeons, on the case of an elephant that died on the 14th of April last of disease of the lungs and subacute inflammation of the bowels, and in which flukes were found in large numbers. The swelling under the jaw is suggestive, but was not always, or indeed often, present. In the only other case (where the parotid glands were swollen) the liver was more healthy and had fewer flukes than any in the whole series.

“ I now proceed [says Lieut.-Col. Hawkes] to give what information I can regarding the amphistoma. This internal parasite is well known to all who possess elephants. It is alluded to by Dr. Gilechrist in his treatise on the diseases of elephants, first published in 1841; but he merely mentioned it under its local name, *masuri*, and made no attempt either to describe it scientifically or to ascertain its place in the natural system. As far as my experience goes it is only found in the intestines. These parasites appear to be very generally present in the elephant. When their numbers are few the ‘host’ is probably not much inconvenienced, but when present in any great quantity they undoubtedly cause much irritation. When this is felt the animal (as before remarked) instinctively resorts to a simple and effectual remedy. He eats a quantity of earth, which purges him thoroughly and expels the amphistoma. The Mahawats are of opinion that whilst the elephant is eating earth to relieve himself of the pests the daily allowance of rice should be scrupulously withheld; and they say that if the rice which is given uncooked is eaten by the animal under these circumstances, excessive purgation is induced, which frequently results in death. How far this opinion is founded on fact I am unable to say, but the Mahawats’ name for this disease, literally translated, means ‘fasting,’ and bears testimony to the generally received notion of the necessity of withholding the rice when the animal is eating earth.

“ But [continues Lieut.-Col. Hawkes], apart from the interest in the study of this amphistoma of the elephant, your

remark that you have recently received from India some amphistomes from the horse has incidentally thrown light upon a subject which has puzzled many of us in this country. It occasionally happens that a horse belonging to one of the mounted branches of the service, on being opened after death, is found to have accumulated in his intestines large quantities of sand or gravel. In a recent case this accumulation amounted to fourteen and a half pounds. Until recently it was always held that this gravel or sand could only be introduced into the animal with his food. All grain in this country is trodden out by bullocks on an earthen floor, and the grain (a small pulse) undoubtedly contains a proportion of sand and gravel derived from this source. Although this *ought to be* carefully washed out before it is given to the horse, still, owing to the carelessness of the native horsekeepers, this cleaning is, I expect, often omitted. In the daily 'feed' of eight or ten pounds of grain given to each horse the utmost quantity of sand or gravel that could be found admixed therewith would not probably exceed two or three ounces; consequently it would take from 77 to 116 days to accumulate so large a quantity as fourteen and a half pounds. Now, the advocates of the theory of the gradual accumulation of sand in this way have never been able to explain why the grain, grass, hay, and other ingesta should pass in the ordinary way through the intestines, whilst this sand or gravel remains behind. One can understand the possibility of such substances as wool, hair, or similar matters concreting in the alimentary canal, though I believe they are usually found in the stomach, and not in the intestines; but how a most cohesive substance like sand can possibly accumulate in the gradual way required by their theory I have never heard even plausibly explained. On the other hand, the fact that horses are often excessively addicted to eating earth is well known; and if my memory serves me correctly, it was found necessary, some twenty odd years ago, to remove the mud-walls round the pickets round some of the horses of a mounted corps in this presidency in consequence of this habit. Now, given the fact that the amphistoma has been found in the horse (as your specimens prove), may we not fairly suppose it possible that the animal resorts to the same mode of ridding himself of this parasite as does the elephant? and also, would it not in a much more natural manner account for the large quantity of gravel or sand found in the intestines than does the present theory of gradual accumulation? Reasoning from analogy, as in the case of the elephant, this eating of earth in the horse would

be an instinctive effort on the part of the 'host' to rid himself of the parasite. This self-taken remedy is doubtless in many cases quite effectual, *though unnoticed*. The fatal cases are probably those in which the horse has either overdone the remedy or where the system was too debilitated to carry off a quantity of sand or gravel that would otherwise have safely passed through the intestines of a horse in more robust health. The actual fact must, of course, be verified by careful investigation, but, the probability of the amphistomes being the exciting cause of this depraved appetite being once allowed, I doubt not that many would follow up the inquiry."

Lieut.-Col. Hawkes having solicited my opinion on this point, I have no hesitation in expressing the belief that in the particular cases he refers to the amphistomes may be a true cause of this earth-eating propensity, and I make this statement in the fullest anticipation of receiving evidence of the frequent occurrence of these parasites amongst horses employed in Her Majesty's Indian Army. From what I have noticed at the Zoological Gardens, however, I strongly suspect that, as in the case of elephants, other kinds of intestinal irritation may produce the same habit in the horse. To be sure, the animals that I have actually seen behaving in this manner are still alive, and it is therefore not certain that they are free from amphistomes, but the keepers have informed me that the habit in question was common with the Indian elephants lately forming part of the society's collection. Lieut.-Col. Hawkes not unfairly observes that the recent discovery of amphistomes in India may have been indirectly brought about by his own previous efforts to throw light on the subject. At all events, he reported on this habit a year previously, expressly pointing out that these earth-eating propensities on the part of the horse were, to all intents and purposes, the same as those indulged in by the elephant. This remark naturally leads me to speak of the equine amphistomes.

As already acknowledged in the *Veterinarian* for last July (p. 513), these amphistomes were sent to me by Mr. F. F. Collins, Officiating Principal Veterinary Surgeon in connection with the Bengal Army. As they were forwarded during the early part of the present year, it is not unlikely that Mr. Collins may have had his attention directed to the matter by the perusal of Lieut.-Col. Hawkes' report. Be that as it may, Mr. Collins' contribution forms a clear addition to the already extensive parasitic fauna of the horse. On referring to his letter addressed to me from Simla on the

22nd of March, 1875, I find that Mr. Collins makes no allusion to the habit in question, but simply writes :—" I forward you by this mail parasites found in the colon of a horse that died a subject of fever peculiar to this country. There were *about a thousand* of the parasites, and nearly the whole of them were situated close to the cœcum, and were loose in the gut. Not having seen parasites at all similar to these, I have taken the liberty to forward them for identification. They were of a brick-red colour when first obtained." These explicit and brief statements by Mr. Collins are highly interesting from many points of view ; and one has only to place his specimens (thirty-three in number) side by side with those from the elephant in order to satisfy one's self that the two forms are totally distinct. The smallest specimen from the elephant is considerably larger than the largest sent by Mr. Collins. This new worm from the horse I therefore propose to recognise as the *Amphistoma Collinsii*, in honor of the donor. It is quite probable that other veterinary surgeons have encountered this entozoon in India, but, unless they can point to some published account of the fact, Mr. Collins is entitled to be considered as the discoverer. Moreover, although the parasite may happen to have been locally known to natives, science equally recognises the discovery as such. In like manner a public reference to parasites thus known, if unaccompanied either by a description or proper scientific designation, leaves it open to any zoologist to name the parasite in any distinctive and suitable manner. In naming the new parasite from the elephant I have been guided by this generally accepted rule, notwithstanding that Lieut.-Col. Hawkes (whose style of writing bears the stamp of a *savant* rather than that of an ordinary observer) has most generously referred me to a previously published notice of the *masuri* by Dr. Gilchrist. In a third communication, dated from Secunderabad on the 11th of August, Lieut.-Col. Hawkes says that the first printed account was by Dr. Gilchrist in 1841, giving a popular account of the parasite, "which had been well known to every elephant attendant since this animal was first domesticated." Notwithstanding Lieut.-Col. Hawkes' unselfish suggestion, I adhere to my original proposal, partly for the reasons already assigned, and partly also from the circumstance that many other European residents in India, Ceylon, and Burmah must, like Dr. Gilchrist, be well acquainted with the *masuri* as such, though totally unaware of the zoological position and significance of the species. Until lately only one species of entozoon from the elephant was recognised as genuine. Now we have admitted

three, and doubtless more will be forthcoming. In regard to the *Ascaris lonchoptera*, of which I have received five specimens, Lieut.-Col. Hawkes communicates no fresh facts, but he promises to send me some parasites (amphistomes) from the ox, and hopes also to send others from the sheep, with a specimen of the well-known intestinal concretions that are so common in Indian cattle. Meanwhile I am under further obligation to Lieut.-Col. Hawkes for enclosing for my use an instructive abstract of a memorandum by a veterinary surgeon on the mortality of elephants at Secunderabad. The reporter, whose initials only are appended (W. S. A.), writes as follows:—"The cause of death is variously recorded; one died suddenly from apoplexy (*i. e.* the 'sunstroke' case in the table supplied by Lieut.-Col. Hawkes), another from atrophy of the heart. The following is a record of the last case that died, and on which I [W. S. A.] made a *post-mortem* examination:—*Symptoms*.—Firstly, usual symptoms of fever, total refusal of all food; subsequently, symptoms of abdominal pain, restlessness, frequently lying down and quickly getting up again, a swelling under the jaw, animal standing with mouth open and head extended. He was latterly much distended, and died somewhat hard eight days after first attack. *Post-mortem appearances*.—Carcase much distended, visible mucous membranes highly congested and of a blue colour. On cutting into abdomen found a considerable quantity of light-coloured serous effusion; the intestines were greatly distended. On the mesentery and at the mesenteric artery was a large quantity of gelatinous sero-albuminous exudation. On laying open intestinal canal found subacute inflammation extending throughout the large intestines; there were also in the large intestines a large number of the round disc-shaped pink-coloured entozoa* found in elephants and called by the natives "masuri." The *liver* was externally of a light slate colour; on cutting into it found a most extraordinary number of the "liver-fluke." The bile-ducts were thickened. On being cut the liver was firm and there was a grating sound to the cut. *Kidneys* healthy. Right *lung* diseased, congested throughout, and hepatized towards the anterior portion. Left lung slightly congested, but comparatively healthy. The mucous membranes of the trachæa and bronchi were congested. *Heart* healthy, with the exception of a small patch of extravasated blood beneath the endocardium on right side. I recorded the "cause of death" to be disease of the lungs and subacute inflammation of bowels. No doubt this was the immediate cause of death, but the large

* These are the amphistomes.

number of flukes in the liver and the intestinal parasites (*i.e.* the amphistomes) account in a great measure for some of the symptoms shown, and these symptoms accord in many respects with those shown in elephants that died in Burmah during the epizootic (rot) in 1867, as recorded by R. B., notably refusal of food, standing with mouth open, restlessness and puffiness about the head and shoulders. The liver parasite is no doubt the same referred to by R. B., and is that termed by Dr. Cobbold *Fasciola Jacksoni* in his work on the internal parasites of domesticated animals" (W. S. A.).

In reference to a later case the same officer remarks:—"I carried out the *post-mortem* examination with special reference to inquiry as to the probability of the mortality amongst elephants at this station being of parasitic origin. This was suggested to me by the former case. The *post-mortem* appearances differed in every respect. There were flukes in the liver, but in no great quantity, and the structure of the liver was sound. Although not assisted by this case in attributing the mortality to parasitic origin, I am strengthened in my opinion that the death of the previous elephant was due to disease caused by the presence of the liver fluke" (W. S. A.).

So much for the veterinary surgeon's report, the results of which are for the most part in harmony with information derived from other sources. Almost every succeeding day supplies me with fresh evidences in reference to the great influence that parasites exert in the production of epidemic disease, alike affecting mankind and animals—the latter indeed from the highest to the lowest degree of organisation. I cannot, indeed, expect that those who have not studied the subject of parasitism so long and patiently as myself should all at once share my views on this subject. My efforts, however, during the past quarter of a century to open out new lines of research in helminthology have not, I believe, been unattended with good practical results. At all events many officers and professional gentlemen have greatly advanced the subject by placing valuable specimens at our disposal; and not a few others (to name only Lewis, McConnell, Oliver, Welch, and Joseph Fleming) have independently contributed memoirs and discoveries, some of which admittedly take rank amongst the most important modern additions to medical literature.

One word more. Mr. Folkard, M.I.C.E., informs me that the Ceylon elephants are great *earth-eaters*, and Dr. J. P. Rowe also tells me that the Australian horses and sheep (infested with stomach worms) consume large quantities of sand.

